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Notes on the Chlorite-Schist Industry of Madagascar's Southeast Coast

William Griffin

1 A long running dissertation project of archaeological survey and excavation, known as the *Matitanana Archaeological Project*, has recently been completed (Griffin 2009[1]). Most of this research was concentrated in the Antemoro region of Madagascar's southeastern coast, between the modern cities of Manakara and Farafangana, focusing on the valleys of the Mananano, Manakara, Matitanana, and the Manampatrana Rivers. However, two additional side projects were undertaken in the attempt to source the artifact material being recovered in the main project (see fig. 1). The second of these ancillary projects, on the quarrying and production of chlorite-schist stone vessels we found on sites dating from the 10th to the 15th centuries, will be the focus of this present paper. (The other side project shown on fig. 1, research up the Matitanana River towards its headwaters to trace the graphite which became a common pottery inclusion in more recent centuries, will not be considered here.) I began the fieldwork for this project in 1994, and drew heavily upon the previous work of Jacques Pannetier (1974) who documented two important sites for chlorite-schist production and consumption: a quarry site northwest of the modern city of Mananjary and a coastal site with numerous chlorite-schist artifacts he excavated near the mouth of the Matitanana River. In our research we were able to relocate both of these sites and place them within a regional context. Our surface surveys discovered and documented 38 new sites with chlorite-schist remains, as well as three new quarry locations in addition to the quarry recorded by Pannetier. We were able to take rock samples from each of these quarries to compare with the composition of the artifacts recovered from the Matitanana region almost 200 kilometers to the south. A preliminary analysis of the trace element signatures through the use of Neutron Activation Analysis (NAA) seems to show that some of the Matitanana artifacts did indeed come from the quarries near Mananjary, that some other Matitanana artifacts came from quarries which are as yet unknown, and that both the Matitanana artifacts and the Mananjary quarries are different in composition from the better known chlorite-schist

sources far to the north near Vohémar. The research leading up to these admittedly provisional conclusions will be the subject of this paper.

2 In addition to Pannetier's archaeological work on chlorite-schist, my interests in this area grew from the existence of numerous ethnohistorical documents produced by the Antemoro called *Sorabe.* These texts in a Malagasy dialect (Beaujard 1998) have been written for centuries in a derived Arabic script, and they have been studied by a growing number of scholars (Beaujard 1988, Dahl 1983, Dez 1983, Gueunier 1986, Munthe 1982, Rajaonarimanana 1990, among others). My goal for the *Matitanana Archaeological Project* was to complement the external and internal historical sources with the archaeology of the region, creating maps of the settlement patterns in different periods.

3 To do this, a ceramic chronology needed to be devised to help assign dates to the sites discovered during the surface survey. Information from 38 excavation units, including stratigraphy and a handful of radiocarbon and thermoluminescence dates, along with the imported ceramics and comparisons to the existing chronologies elsewhere in Madagascar were all combined to create the archaeological phases depicted in table 1 for the Matitanana region (see also Griffin 2009 chapter 5). I have more confidence in the sequence of archaeological assemblages than I do in the exact duration of the chronological phases depicted in this table, but hopefully future work can further refine this picture. Table 2 shows how this system compares to its nearest neighbors in Madagascar, though as Crossland (2001:117) has noted, chronologies such as this can give the false impression that change is only marked at the beginning and endings of such phases. Change in artifact assemblages may be punctuated in such a manner, but it may also be spread out more evenly throughout a single phase, and thus many of the hard vertical lines in this table can be conceived of as quite fuzzy in reality.

Fig. 1. The *Matitanana Archaeological Project* and ancillary project areas, including the sites near Mananjary related to chlorite-schist production

4 To summarize the results of the main project, the chronology of table 1 was applied to the survey data to produce settlement maps for each phase. These maps show the arrival of humans sticking close to the coastline during the Marovahiny phase and eventually spreading upriver to settle throughout the valleys during the following Mananano phase. However, in the 15th and 16th century Ambohabe phase we see two distinct settlement patterns emerge. North of the Matitanana River mouth were found two large settlements (or clusters of dense villages) stretching for over a kilometer each along the coast, but the valley upriver was empty for some 20 kilometers until the older pattern of scattered small hamlets resumed, along with the two earliest ditched hillfort sites on either side of the river (Griffin 2009:182). The development of this "no-man's land" between the two regions, land which had been occupied in the previous phase, could indicate the arrival of the ancestors of the modern Antemoro people and of their conflict or competition with the original inhabitants who were forced to retreat upstream. The following Sangilavitra phase sees the filling in of this abandoned land (presumably with the newcomers victorious), as well as the creation of ditched hillfort sites across the region (27 of these *manda* were documented in our surface surveys). This phase corresponds with other military incursions to the area, such as that of the French officer La Case in 1661, a campaign described in the local *Sorabe* documents as well as in other historical texts. Interestingly, some of the same place names used in these early *Sorabe* texts were found on survey to still be applied to ditched hill sites in the region. The sequence of settlement patterns revealed by the archaeology is an interesting result of the main *Matitanana Archaeological Project*, but the research also led to other results worth considering. The rest of this paper will focus on what this research can tell us about chlorite-schist production and consumption on Madagascar's southeast coast.

5 Mananara and Fenoarivo are two areas of active archaeological research north of Toamasina that share a similar ceramic chronology, though they are separated from each other by approximately 130 km.

Tab. 1. Chronological Phases, Matitanana Archaeological Project

Tab. 2. Regional comparision of archaelogical phases

Fieldwork near Mananjary

6 As mentioned above, the most important precursor for my work was that of Jacques Pannetier who worked in this region in 1972 as part of a master's thesis (Pannetier 1988[2]) and published the results as an article in *Taloha* (Pannetier 1974). His fieldwork was followed by a University of Madagascar fieldschool at the important site of Ambohabe, with 30 students excavating in September 1973 (Rasolofoson *et al.* 1974:196-210) and 33 students excavating in October 1973. Pannetier was primarily interested in chlorite-schist production on the Southeast coast. He noted that the most famous archaeological remains for this coast were the "grand jar" at Ivondro near Toamasina and the "stone elephant" at Ambohitsara near Mananjary. Both of these are sacred objects attributed to the mythical ancestor Raminia who traveled down the East Coast - a tradition recorded in a *Sorabe* translated by Ferrand in 1902 and included in *Taloha* 6 (Ferrand 1974). This "stone elephant" has more recently become the focus of study for the avocational archaeologist Theo Detjen, as will also be discussed below.

7 In trying to source the chlorite-schist artifacts found in the region, Pannetier examined the early twentieth-century reports to the Academie Malgache by various colonial officials, and discovered three mentions of sites with chlorite-schist artifacts. Two are quarry sites northwest of Mananjary, and one is a site with reported chlorite schist vessels in the plantations of the Protestant Mission at Mananjary. Pannetier was able to visit the mission site, but found no archaeological remains through survey or excavation. As this site was only reported as a location with chlorite-schist vessels, it was most likely similar to other coastal sites we've recorded for this project with extensive chlorite-schist remains, and was not itself a quarry site. The first chlorite-schist quarry site referenced in the literature ("site Rakoto Franck," reported in 1915) was judged by Pannetier to be too remote to visit in the available time, though Pannetier did relocate it on the map north of Mananjary and south of the Fanantara River (Pannetier 1974:55). Thus, his work focused on the second quarry site ("site Dalais" reported in 1919) and the "newly discovered" site of Ambohabe, over 150 kilometers to the south on the Matitanana River. We attempted to relocate this second quarry site, "site Dalais," to obtain samples of the rock for further analysis. I am confident that our team did find the site visited by Pannetier (though it is not clear that what we have labeled as Site 240 is also the same site that Dalais reported in 1919). Locally this spot is known as "Ambatobe" meaning "place of

the big stone," and the area is most easily reached on foot from the town of Ambalanaomby, which is presently accessible by car.

8 Our team was able to relocate Pannetier's "Site Dalais" (our Site 240) and obtain chlorite-schist samples from the quarry. However, the site we sampled was 12 kilometers southeast of the site location indicated on Pannetier's map (he places the quarry near the village of Ambohimanarina at Laborde coordinates 560.5, 570.2, on F.T.M.'s map Q-52, 1976; whereas we found the site at 569.4-567.3 on map R-52, 1978). I am sure we were at the same location because his unpublished manuscript (Pannetier 1988) included a photograph of this quarry that was not included in the 1974 article (see fig. 2 below for both of our photographs from approximately the same angle), and because one of our team members, Mr. Ramilisonina, also helped Pannetier discover this site originally and remembered the location. I am also relatively sure of where that location should be placed on the map, thanks to a handheld GPS unit (reading 21 01.51'S and 48 04.05'E). I believe the initial mistake arose from the unfortunate similarity of three different village names (all beginning with *Ambohi* and ending with *niarina*, *miarina*, and *manarina* respectively), located near two different streams both named *Mardena* that each flow into two different rivers both named *Imana*. The common repetition of meaningful place names in Madagascar convinced us, in part, to switch to assigning unique site numbers starting in our third field season for the *Matitanana Archaeological Project*. Though Pannetier's mistake did add a few days to the time it took us to relocate this quarry, I'm greatly indebted to his pioneering work, and know that I too have most likely misplaced a few of the sites recorded for my project, especially in the earliest seasons without a GPS unit.

Fig. 2. Pannetier at the chlorite-schist quarry he called "Site Dalais"

Ramilisonina at the same location

9 The hill on which this quarry is located is marked "Ambatobe" on F.T.M.'s map R-52, 1978 (see fig. 3). We assigned the site number 240 to this location, and chipped off four small pieces of the stone from different parts of the outcropping for further analysis, including Neutron Activation Analysis as will be discussed below. As visible in the photographs above, many stone blocks had been outlined with picks and then removed from one side of the outcropping, and one of these blocks still remains higher up on the stone – a round

block measuring 46 by 28 by 25 centimeters deep on the northeast face. From this location we could see no other rock outcroppings on this hill, and so this is most likely the reference in the name Ambatobe. However, in our efforts to find this site we also located three other chlorite-schist outcroppings that have been quarried. This means, as one might expect, that chlorite-schist procurement was a regional activity and not confined just to the one outcropping at Ambatobe. I think it likely that other quarries exist in this area and to the north, in addition to the four that we have documented for this project.

10 In fact, the largest and most active quarry location we discovered was M.A.P. Site 239, just below Ambatobe in the Mardena stream. At least six different rock outcroppings at this location have evidence of the removal of quarried blocks. As at the other sites, pick marks are clearly evident in the stone as well as a few intact blocks (see fig. 4 and 5 for examples). Site 239 was also the only site in the area with the remains of worked chlorite-schist, in the form of a partially finished bowl and two chlorite-schist body fragments. Unfortunately, we did not recover any pottery during our surveys in this region, and thus the dating of this mining activity remains ambiguous. It does seem clear however, given this paucity of artifacts, that the procurement of chlorite-schist was probably undertaken by individuals who were not living permanently on or near these sites, but who rather would travel here to obtain the stone in rough-shaped blocks, which were then turned into finished vessels at some other location. As seen in the site map (fig. 3), sites 238 and 239 were probably parts of the same work area, as they are within sight of each other. In between those two sites we found a squat cylinder of chlorite schist (30 centimeters in diameter and 15 centimeters thick) that had been moved 20 meters from its quarry spot, then abandoned, and is now lying half buried in the dirt.

11 There was no indication of any modern use of these rock outcroppings, or the land in their vicinity, with the exception of the first quarried outcropping we found. This site (237) had cavities left by seven blocks removed, as well as two outlined blocks that were still intact (see fig. 5). The flat horizontal surface of the top of this outcropping (at 1.8 meters high) had the words "Vato malemy" carved into its surface, meaning "soft stone." Locals we talked with said this type of stone is generally referred to as *vatosia*, and elsewhere in Madagascar it is known as *vato didy* – "stone you can cut." We found it ironic that after days of being lost (on Pannetier's map) while hunting for a chlorite-schist quarry, the first one we encountered had been so conveniently labeled for us. It was doubly ironic since we had spent the drive up to this area from the Matitanana recording similar roadside graffiti for another project (see Griffin 1999). Twelve of the rock samples collected from these quarries were subjected to NAA analysis along with artifact samples from the Matitanana region, as will be described in the section below on laboratory work.

Fig. 3. Map showing chlorite-schist quarries, sites 237 to 240

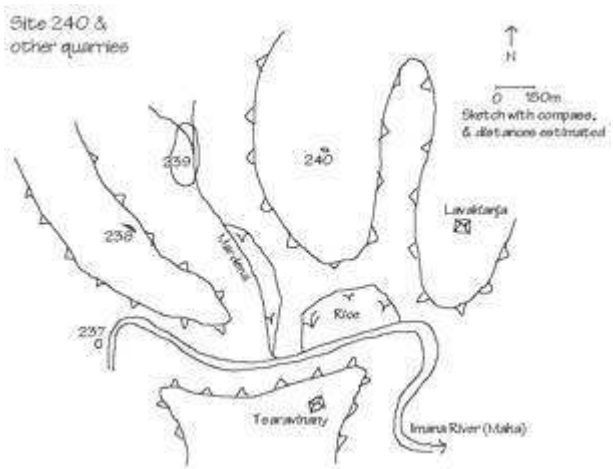


Fig. 4. Site 238 Profile, with rock samples removed for analysis indicated. Block voids average 20 to 30 centimeters deep.

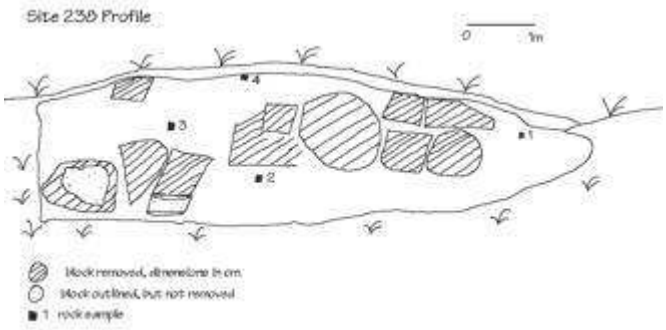


Fig. 5. *In situ* chlorite-schist quarry blocks, with trowel for scale, site 237

12 Since our surveys did not recover any evidence of habitation near the chlorite-schist quarries themselves (though more extensive survey work might change this picture), we decided to look downstream near the confluence of the Imana River with the Mananjary. We were hoping to find indications that the rough chlorite-schist blocks taken from the quarries up the Imana and been further worked in this area, but surveys in villages and farm fields did not recover any such evidence near this confluence. However, we did discover one interesting archaeological site, site 212 at Tsiatosika, north of the village of Ambohitrova. This site consists of a large, sparse sherd scatter covering the western slope

of a hill just north of the modern village (see fig. 6 and 7). The remains of a collapsed stone wall were found on the south east slope of the hill at Waypoint 212 B, and it appears that this stone wall once encircled the level top of the hill, approximately 50 meters across, with probable gates to the north and south. The possible ditches to the west had been transformed into 3 terraces for gardens, and the flat top of the hill presently supports banana, coffee, mango, jackfruit, orange and breadfruit trees all in one small area. Our informants in Ambohitrova (the President of *Fokontany*, Florent di Lala, and the local blacksmith, Raoelison Tavy) claimed that this hilltop was once a Merina fort (as the name of their village might imply). Local oral tradition claims this hilltop was the fort of a Betsimisaraka king Radaba who was defeated and replaced by a Merina king Radavid before the French arrived in 1896. Traditions tell that this Merina king aided the noble Anteony clan of the Antemoro, who had fled to this area during a civil war in the Matitanana region. We were able to visit a village of the descendants of these Antemoro refugees at the village of Mahatsara, who confirmed the stories we had heard at Ambohitrova.

Fig. 6. Site 212, Tsiatosika (Labordes 585.6-544.5)

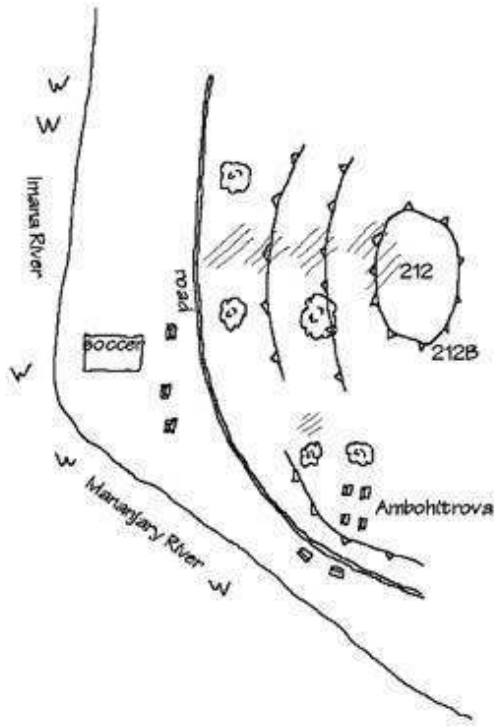
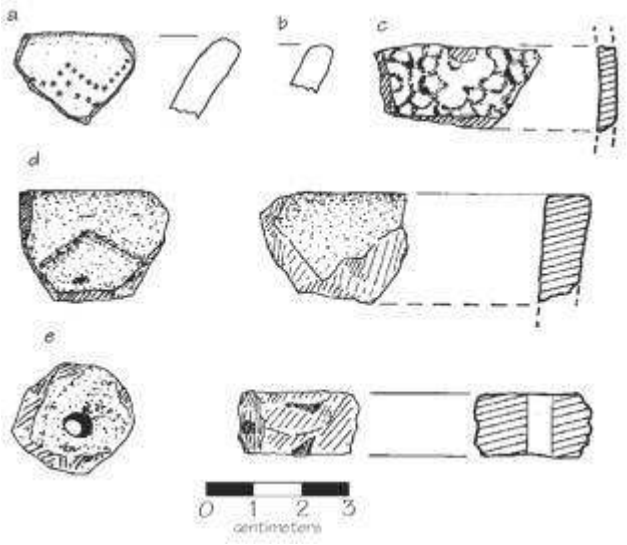


Fig. 7. Artifacts from Site 212 (Tsiatosika) and Site 213 (Ambohitsara)



A. SITE 212, DECORATED RIM SHERD, GREY GRAPHITE WARE, 6.8G, T =.69, WITH ROUND PUNCTATES IN A CHEVRON PATTERN AND A SQUARE LIP.
B. SITE 213, PLAIN RIM SHERD OF GREY GRAPHITE WARE, 1.5G, D =14 (3 % OF RIM), T =.59, WITH A SQUARE-ISH LIP
C. SITE 212, EUROPEAN BLUE AND WHITE FLORAL PATTERN, 3.6 G, T = .40
D. SITE 213, DECORATED POTTERY RIM SHERD, 8.6G, D = 23 (3 % OF RIM), SAND INCLUSIONS (2, 10 %), GREY (BUT NOT GRAPHITE) WITH LINEAR INCISIONS ON INTERIOR SURFACE.
E. SITE 213, CHLORITE-SCHIST WEIGHT OR BEAD, 12.1G, T =2.31CM, HOLE DIAMETER = .58 CM

13 The artifacts recovered from site 212 were assigned to the Ampasimeloka phase, which, despite the distance from the Matitanana, seems accurate given the oral traditions collected concerning the site. The site is thus more recent than the chlorite-schist quarry sites, and belongs to a phase where pottery with graphite inclusions seems to have replaced the use of chlorite-schist vessels. However, while not helping us with our investigations of the production of chlorite-schist objects in this region, this research did reveal some of the regional effects of the conflict between social groups in the lower Matitanana River, which was the main focus of the *Matitanana Archaeological Project*.

14 A brief visit to the coast north of Mananjary did reveal two sites that connect more directly to chlorite-schist production in this area. As mentioned above, one of the most famous objects in all of Madagascar is the *vatolambo*, a large animal figurine carved from chlorite-schist found in the village of Ambohitsara, 42 kilometers north of Mananjary. During our 1999 fieldseason, we had the opportunity to visit this site in the company of the Museum of Art and Archaeology's director, Jean-Aimé Rakotoarisoa. However, after a series of unexpected boat failures and broken motors, our time in the area was severely reduced and we were not able to undertake any systematic surveys. Thus, we were only able to visit and record two archaeological sites in this region, including the village of the "stone elephant" itself, which was recorded for our project as Site 213 (Labordes 610.9-582.0). This thirty-house village of Ambohitsara contained a sparse sherd scatter of approximately 70 by 70 meters. Both pottery and chlorite-schist fragments were recovered during the brief survey, though not much of either. The complete recovery yielded:

- 4 chlorite-schist body fragments, 34.3g, including 1 with cut marks, t = .44, .81, .96, 1.26 ;
- 3 unshaped fragments of chlorite-schist, 19.1g;

- 5 plain brown ware body sherds, 10.8g, t = .36, .54, .69, .69, .88;
- 1 plain body sherd, 1.0g, of soft, orange-ish ware;
- 3 plain body sherds of grey graphite ware, 10.3g, t = .47, .58, 1.11;
- and the 2 rim sherds and a chlorite-schist weight or bead illustrated in fig. 7 b, d, e.

15 The pottery was tentatively dated from the 17th to 19th century, but the sample size is too small to have much confidence in this assignation. Of note, we did recover a chlorite-schist bead from within two meters of the *vatolambo* statue itself. Test excavations in this historic village could possibly reveal older cultural deposits, such as those we recovered nearby at site 211 (to be discussed below).

16 Our archaeological team went to Ambohitsara to see the famous "stone elephant", the *Vatolambo* (fig. 8), as did Pannetier's team before us, but this object has long attracted many visitors (as evidenced by the graffiti now covering its flanks, see fig. 9). Molet and Vernier (1954) interviewed the local Tambahoaka who claimed the *vatolambo* had originally held *Sorabe* texts which were stolen by the same vandals who put the graffiti on the object. In 1957, H. de la Roche undertook a petrographic analysis of a sample taken from the statue and found it to be a different sort of stone than that from the Vohémar region (Vérin 1975:910, and Vérin (1975:909) also suggests that the statue is of a hippopotamus rather than elephant). One of the more recent visitors was an independent scholar named Theo Detjen who spent ten weeks at Ambohitsara studying the *vatolambo.* Detjen created a substantial two volume work on the subject (Detjen 1998a, 1998b), copies of which are available at the Musée d'Art et d'Archéologie, Antananarivo (and this work was not known to me until after we had completed our short fieldwork in the area). Detjen's primary argument was that the chlorite-schist sculpted animal roughly one meter high and two meters long was not an elephant but actually a wild boar, and thus he prefers the term *vatomasina* (sacred stone) rather than the local *vatolambo*. Detjen undertook a thorough study, exploring the neighboring region trying to source the stone of the sculpture. He traveled up the Fanantara River (towards the quarry first reported by Rakoto Franck in 1915, and situated on a map by Pannetier 1974:55) and discovered three quarries near the village of Ambatoseza (it is unclear how these quarries relate to those discussed by Pannetier since we were not able to visit that area ourselves). Detjen conducted a number of "superficial sondages" at the largest quarry near Androrangalava, and hired porters to carry a 60 kilogram sample of the material back to the town of Ambatoseza (Detjen 1998a:43). What happened to these quarry samples after they reached this town in not clear from the report, and this stone was not included in the neutron activation analysis discussed below.

17 The past inspires passion in many people (myself included), but Detjen's enthusiastic reports could easily fall within that category of work classified by some as pseudo or "fringe" archaeology (Griffin 1991). One of the main goals of Detjen's research is to link the *Vatolambo* with early Chinese bronzes, which often depicted wild boars. Thus, while noting the symbolic nature of the number nine for the Chinese, he found meaning in his measurement of the *Vatolambo* as being 180 centimeters long — "a multiple of nine!" (Detjen 1998b:7)... implying that a local sculptor had relied on the metric system centuries ago. He then uses this purported Chinese connection to argue that the first immigrants to Madagascar were Chinese who arrived in the second century B.C. He buttresses this date by pointing to a Chinese emperor of the period who sent out a navy of young men with instructions to "find paradise" and the assertion that since Buddhism arrived in China in the first century B.C., and since there are no early statues of Buddha in Madagascar, then

the settlers must have left China before the first century. Of course, early connections between Madagascar and China may be revealed some day, but for now our limited archaeological evidence does not support Detjen's arguments.

Fig. 8. Site 213, the *vatolambo* of Ambohitsara

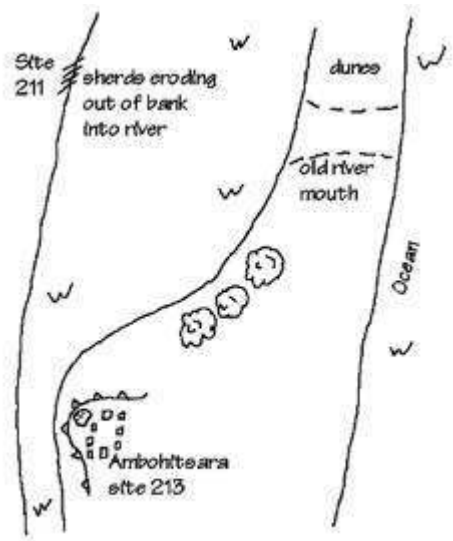
Fig. 9. Graffiti on the *vatolambo*

18 However, Detjen's work can serve as a reminder for how common, yet un-obvious, archaeological remains can be. Once we learn what to look for, archaeological survey is simple, but before being shown, many people do not take note of the mundane things on which we base our discipline. After spending weeks living in Ambohitsara (and his report includes an excellent map of the village), Detjen still wondered why there were no other chlorite-schist artifacts in the town, concluding that they must have been completely destroyed and removed by immigrant Muslims arriving in the Middle Ages, the same Muslims, in his opinion, who transformed the stone boar to look more like a stone elephant for religious reasons in "purifying the village" (Detjen 1998a:64). He may have been expecting or looking for whole vessels as artifacts, because our quick survey revealed a number of chlorite-schist vessel fragments within sight of the *Vatolambo*. Despite the errors in his report, Detjen's discovery of chlorite-schist quarries up the Fanantara is a significant contribution, and it is hoped that those quarries can be recorded and sampled at some point in the future.

19 Though we had only limited time in the area, we were able to record a large and very early site just north of the village of the stone elephant. Site 211 was a very dense sherd scatter exposed in the river bank north of Ambohitsara towards the village of Ampaho (see fig. 10). My collaborator Ramilisonina had visited Ampaho in 1998 with the ethnographer Sophie Blanchy, and it was around this site that our original systematic

survey had been planned (though we were not able to carry it out). In May 1999 we recorded exposed sherds along a 70 meter stretch of the river bank. The artifacts were consistently found in a dark layer containing charcoal and artifacts between 80 and 100 centimeters below ground level, but the water surface was above this height and the ripples were clearly eroding artifacts into the water. We recorded 4 layers in the bank profile: layer 1 (0-38cm, humus with many roots), layer 2 (38-80cm, light brown with no artifacts), layer 3 (80-102cm, dark with charcoal and many artifacts, with the water level currently at 92cm b.g.s.), and layer 4 (below 102cm, a grey clay layer which appears to be sterile.) The high water in May is clearly eating into and destroying the site, but this would be an ideal place to excavate when the water is lower in October. I believe the artifacts recovered are very early, the equivalent of the Marovahiny phase for the Matitanana region. But the pottery also differs substantially from Marovahiny phase sites found in the main project area to the south. For instance, the earthenware bowl illustrated in fig. 11 has chlorite-schist inclusions (as is common for the early Marovahiny phase), but it takes a form we did not recover from any other site: a red-slipped open bowl with a foot-ring base. Site 211 also had a high percentage of chlorite-schist vessels, and more significantly, much evidence of the carving of stone vessels on site, judging by the number of unfinished abandoned blanks. figure 12 illustrates four objects recovered from site 211 in different stages of manufacture, none of which are complete. A few sites in the main project area further south (such as M.A.P. Sites 62 and 214 near Manakara) also appear to have been centers of industrial craft production based on their iron slag and chlorite-schist remains. However, the artifacts recovered at Site 211 imply a much more intensive chlorite-schist industry given the greater density and size of the recovered remains. It makes sense that this coastal site, much closer to the actual known quarries, would contain much more extensive evidence for the working of larger pieces of chlorite-schist. As stated above, because of time constraints only Ambohitsara (site 213) and the river bank site near Ampaho (site 211) have been surveyed in this region. No systematic archaeological survey of the surrounding landscape has yet been undertaken. But given these initial findings this is clearly an area that should interest future archaeologists.

Fig. 10. Ampaho, Site 211
(Labordes 611.6-583.6; 20.84477 S, 48.4703 E)



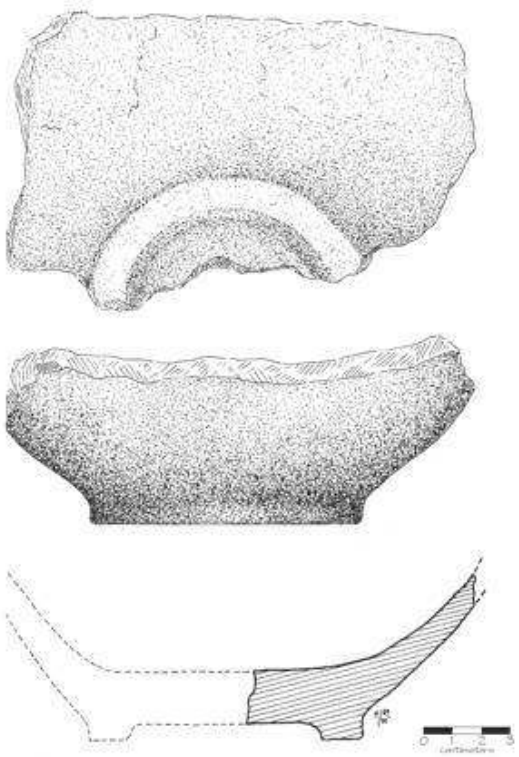
20 This project of ancillary fieldwork near Mananjary yielded a large and dense early coastal site with much evidence for the working and carving of chlorite-schist vessels (Ampaho, Site 211) as well as a series of worked quarries from which chlorite-schist blocks had been removed (Sites 237 – 240). These results, along with the previous work of Pannetier and Detjen, give us some insight into the chlorite-schist procurement and craft centers in this part of Madagascar, though more thorough work in the region is needed. We know that such finished stone vessels were commonly produced on Madagascar's northeast coast and were widely traded throughout the Indian Ocean. The work discussed in this paper shows the need to consider Madagascar's east and southeast coasts as well to better understand this ancient industry.

Fieldwork near the Matitanana

21 Our fieldwork in the Matitanana region did not reveal any stone quarries, but we did find many sites with evidence that chlorite-schist vessels were used, repaired, discarded, broken up to serve as inclusions in pottery paste, and also reworked into fishing net weights. Similarly, Pannetier's original work on the southeast coast was focused on two main sites: the quarry site (M.A.P. Site 240) discussed above and a consumption site at Ambohabe on the coast just north of the Matitanana River mouth.

22 This important site of Ambohabe was shown to Pannetier by the residents of the town of Seranambary after he showed them a few pieces of chlorite-schist (Pannetier 1974:57). Finding a surface scatter that included chlorite-schist fragments at Ambohabe, Pannetier excavated by natural layers two trenches of two by one meter. He provided excellent illustrations of the artifacts recovered in his *Taloha* article, designated by square and strata (a, b, or c), followed by what I believe to be a sequential find number. This excavation site was recorded as Site 3 for the *Matitanana Archaeological Project* (Labordes 552.6-411.4; 22.40567 S, 47.91917 E) based on a surface collection. We did not undertake any new excavations at this location, and unfortunately, I was not able to relocate the illustrated artifacts from Pannetier's earlier excavation. Pannetier did not assign a date to any of the strata or to the overall site, but based on his illustrations and our work nearby, I have designated an "Ambohabe phase" of the 15th and 16th centuries based on this site.

Fig. 11. Ampaho bowl, Site 211



OPEN BOWL WITH FOOT RING BASE, RED SLIP INTERIOR AND BLACKENED EXTERIOR, SAND AND CHLORITE-SCHIST INCLUSIONS (SIZE 3, 10 %), 281.4 GRAMS, OUTSIDE DIAMETER OF FOOT-RING = 9.5CM.

Fig. 12. Chlorite-schist artifacts, Site 211

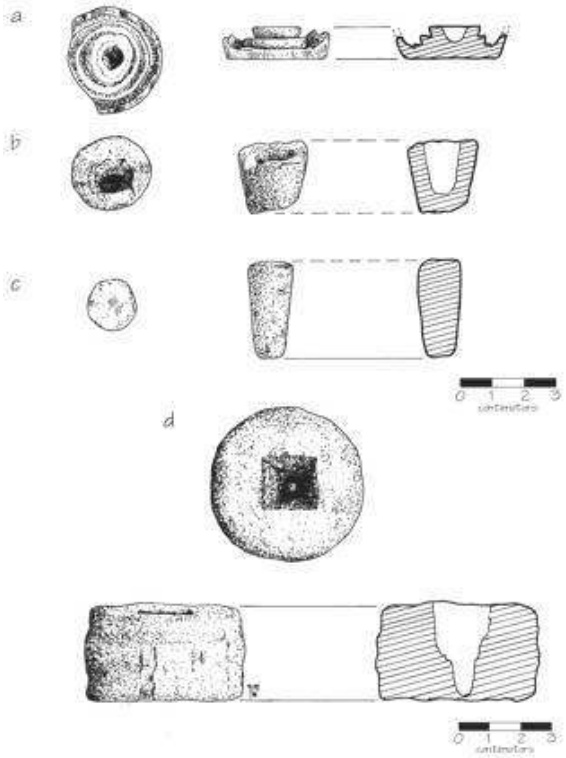
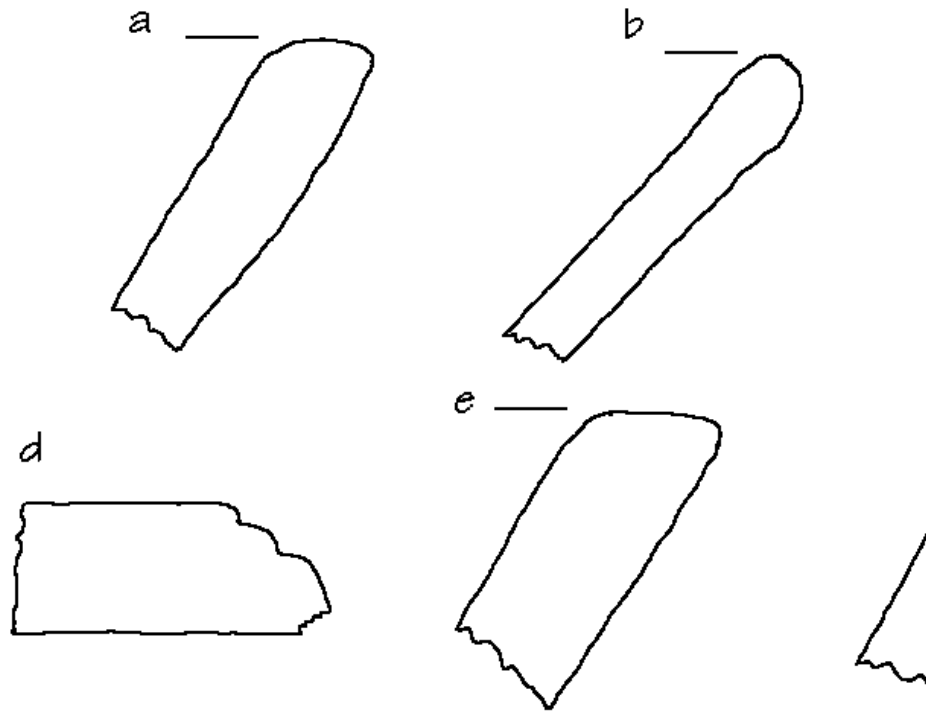


Fig. 13. Chlorite-schist weights, Site 211

ARTIFACTS A (2.7 GRAMS) AND B (5.1 GRAMS) ARE MOST LIKELY BEADS, WHILE ARTIFACT C (25.4 GRAMS) IS A FISH NET WEIGHT. THE CHLORITE-SCHIST BODY FRAGMENT D (23.2 GRAMS) WITH INCISED GROOVES ON THE INTERIOR (RIGHT) AND EXTERIOR (LEFT) SURFACES IS FROM SITE 211A.

Fig. 14. Site 211, artifacts



A. PLAIN RIM SHERD (POTTERY), 20.2g, D =27 (3 % OF RIM), T =.87, LIP T =1.14, SAND INCLUSIONS (2,5 %), HEAVILY BURNISHED INTERIOR AND EXTERIOR.
B. PLAIN RIM SHERD (POTTERY), 28.8g, D =32 (5 % OF RIM), T =.70, LIP T =.81, CHLORITE-SCHIST INCLUSIONS (3,15 %), WITH RED SLIP INTERIOR.
C. CHLORITE-SCHIST PLAIN RIM FRAGMENT, 122.6g, D =34 (10 % OF RIM), T =1.44, LIP T =1.12.
D. CHLORITE-SCHIST LID FRAGMENT, 39.5g, T =1.41, WITH PART OF LIP MISSING.
E. CHLORITE-SCHIST PLAIN RIM FRAGMENT, 57.7g, D =31 (7 % OF RIM), T =1.36, LIP T =1.40, FROM SITE 211A.

23 Pannetier's interpretation of Ambohabe was based on information he received from an old man (born in 1898) from the nearby village of Ambohitsara (though note that this is not the village of the stone elephant with the same name discussed above). This man claimed that the Onjatsy people, who eventually abandoned the site of Ambohabe for their current village, were the first settlers in the region. After this, the site remained vacant for a long period, until occupied by the Merina from the central highlands at the beginning of the 19th century. Also according to this source, at the end of the 19th century, a European family named Aguis settled at the site and created a coconut plantation there (Pannetier 1974:58). Pannetier noted the large number of fish net weights recovered in his excavations (made primarily from recycled chlorite-schist vessels) and linked this with an observation made by Flacourt in the 17th century that the Onjatsy were above all fishers and sailors, in order to confirm the ethnic assignation of Ambohabe with the Onjatsy. Our work in the Matitanana region encountered similar traditions, though we also heard competing claims from other groups in the valley. I would briefly note that Pannetier's informant was from the village of Ambohitsara, a village which is said to be a commoner village traditionally allied with Onjatsy. The aristocratic Antemoro clans also claim that they were the first ones to settle at Ambohabe before moving inland to their present-day villages of Ivato, Vatomasina, and elsewhere.

These different conceptions of the past are related to, and used in, contemporary political struggles over land rights - with the royal Anteony clans preventing the Onjatsy from erecting their commemorative marker at the site of Ambohabe. Unable to erect the monument at site of Ambohabe, the people of Onjatsy have allowed this stone with its *Sorabe* inscription to lay on its back in their village for decades (see fig. 15). While Pannetier's ethnic identification of the first settlers at Ambohabe based on fish net weights is not clear cut, I would agree that the archaeological evidence indicates fishing was important for these earliest inhabitants.

24 As for the other parts of this oral tradition reported by Pannetier, we found no evidence of Merina occupation near the Ambohabe coastal sites, though we did recover evidence of the Merina elsewhere in the river valley. As for the European family, only two sites on the coast north of the Matitanana River mouth had European ceramics: some 700 meters north of Pannetier's excavation site was a small scatter at M.A.P. Site 11, and eight kilometers north was a larger concentration of European wares along with many iron implements at Site 22 (see Griffin 2009 for these and other survey results). This latter site is locally known as "Antanambazaha," or the "place of the foreigners," and we interpreted it to be a temporary work camp used during the construction of the nearby Pangalanes Canal, though it could as easily have been part of a colonial plantation. However Site 11, which is much closer to Ambohabe, may well be connected with the Aguis family, though very few vessels were represented, and we found no structural remains or other evidence of European occupation. The two historic sites merit further attention and some historical research in the archives of Madagascar and France.

Fig. 15. Concrete monument with *sorabe*, in the village of Onjatsy, rather than at the archaeological site of Ambo-habe

25 Following Pannetier's work, in 1973, two University field schools were held at the site of Ambohabe, though fieldnotes beyond the short publication describing this work were not obtainable ("Annexe," Rasolofoson 1974). This annexe included an important site map that Pannetier's work lacked that helped us put the excavation trenches into context, though the artifact descriptions and illustrations were not as thorough. The map indicates two large trenches and eight sondages scattered across a large area at Ambohabe (Rasolofoson 1974:197). Trench B appears to be 21 meters by one meter in size, and ten square meters from this trench are described in the publication. The map also indicates sondages X1 to X3, Y1 to Y3, and Z1, but we have no information about the results of these soundings. The museum storerooms in Farovohitra contain the artifacts recovered during these fieldschools, and we were able to examine sherds from 53 different excavated squares (including 12 squares labeled E through P, though it is unclear where at Ambohabe these sondages were situated). Unfortunately, the sherds are labeled with only the square designation and a sequential number, so there is no indication of the depth or layer for each artifact. Thus, even though some 60 square meters had been excavated during these fieldschools at Ambohabe, the material recovered is not as useful for creating a ceramic chronology as Pannetier's four square meters, since these later artifacts can only be provenienced by square (in some cases) and not to a level or layer. The greater volume of material recovered from this site is useful, however, for learning the range of wares present and in recovering the more rare artifacts, such as beads, which were exposed due to the greater volume of earth moved (though it is probable that screening was not employed given the size of the artifacts collected).

26 The students on these two fieldschools were also interested in the ethnography of the Antemoro, and they recorded and described the most common origin myths for the Antemoro (that they sailed straight from Mecca to the Matitanana), and, presumably on these grounds, they assigned a 16th century date to Ambohabe, based on when people "first arrived at the Matitanana" (Rasolofoson 1974:196). They also recorded the current political structure with a king for each of the three different clans (royal Anteony, religious Antalaotra, and commoner Ampanabaka), and recorded a number of the local taboos (*fady*). In this latter section of their article they note the prohibition on marriages with the "caste" Antevolo (an outcaste group discussed as the Antemanaza in Griffin 2009:50 and possibly the descendants of the original inhabitants of this region).

27 This is the prior work[3] that prompted my research in the area, and as mentioned in the opening of this paper, our fieldwork near the Matitanana did discover a number of other sites with numerous chlorite-schist remains in addition to the Ambohabe site excavated by Pannetier and the students. For example, a garden at the site of Mangarivotra (M.A.P. Site 9, Labordes 552.5-410.9; 22.4105 S, 47.91783 E), approximately half a kilometer south of the previously excavated Ambohabe (M.A.P. Site 3), yielded a number of relatively large pieces of chlorite-schist (as seen in fig. 16). The surface artifacts collected from this site of Mangarivotra were assigned to the chronological phases before and after the Ambohabe phase (seen in fig. 17 and 19), but they do give a sense of the types of heavy, footed chlorite-schist cooking vessels imported to the region. This sequence of three settlement maps for just the lower Matitanana River (fig. 17, 18, and 19, and table 1 for a description of the phases) also illustrates an important result for the overall project: that the lower river valleys were abandoned during the Ambohabe phase (except for a few large clusters of coastal settlements), and that this "no man's land" might reflect the arrival of the

ancestors of the Antemoro people and their conflicts with the original inhabitants (whose villages with the earliest hillforts were found some 20 kilometers upriver and are not shown on these three maps).

28 The other river valleys surveyed for this project also possessed early sites with chlorite-schist artifacts, such as the type site for the Mananano phase, M.A.P. Site 214 north of the modern city of Manakara near the mouth of the Mananano River. Excavations at this very early site (see site map in fig. 20) yielded a large number of chlorite-schist artifacts along with some unique pottery forms not found elsewhere in the region (such as the rim sherd in fig. 21.b.). Some of the chlorite-schist artifacts recovered from the excavations and surface surveys on this site are illustrated in fig. 21, 22 and 23.

29 These artifact drawings give an idea of the chlorite-schist artifacts recovered during the *Matitanana Archaeological Project*, but to look quickly at two final artifact types before moving on to the laboratory analysis, please see figures 24 and 25. Pendant weights similar to that shown in figure 24 were found on a number of different sites (one of which is illustrated in fig. 13c), though most did not have the hole drilled through them as this artifact has. On the other hand, the artifact in figure 25 was unique and nothing similar to it was found at any other site.

Fig. 16. Mangarivotra, Site 9, chlorite-schist artifacts

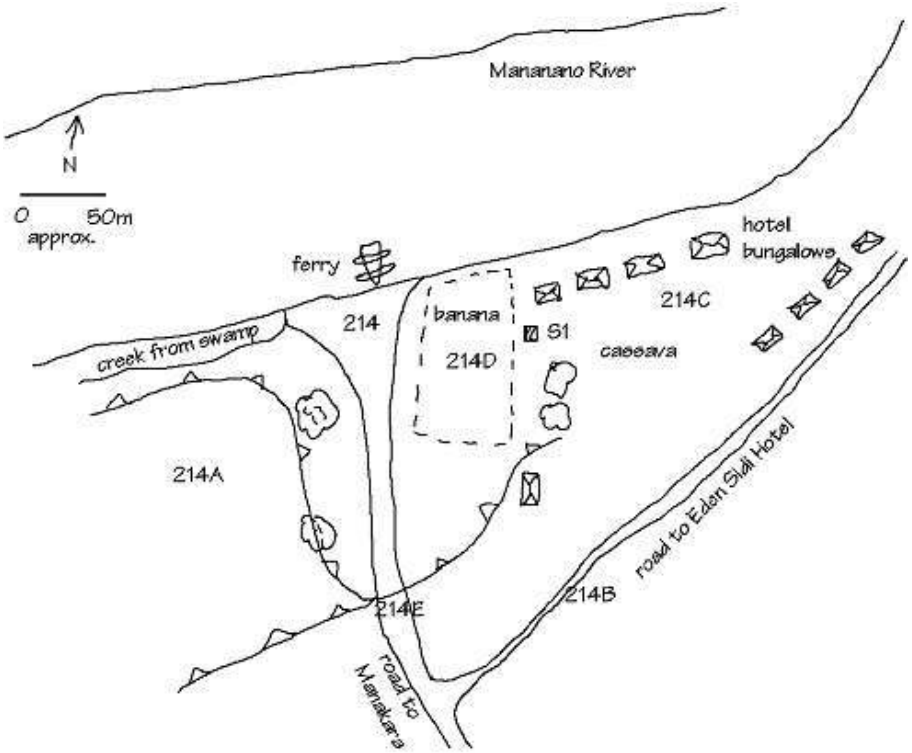
A. Stone lid knob, deeply pitted, light grey stone, knob diameter 4.77cm.
B. Chlorite-schist lid (or less likely an open bowl), D =24cm (8 % of rim), T =1.52, 7.5YR4/0, with 1 repair hole (hole D =.53cm)
C. Decorated pottery body sherd with deep incisions, T =.71, exterior 7.5YR4/1, interior 5YR6/3, 3 grams).
D. Chlorite-schist leg fragment with incised lines (also drawn from below to show depth of incised lines).
E. Chlorite-schist fragment, possibly a leg, with deep incisions on one surface, T =1.8, no magnetic attraction.
F. Chlorite-schist object with a conical hole carved into one end, T =2.9, hole diameter = 1.55cm, hole depth = .8 cm (possibly a blank being drilled for a soapstone tuyere, see Linton 1933: 82 for soapstone tuyeres in use by the Tanala)

Fig. 17. Mananano phase sites in the lower Matitanana River valley

Fig. 18. Ambohabe phase sites in the lower Matitanana River valley
(Site 3 is Pannetier's Ambohabe)

Fig. 19. Sangilavitra phase sites and hill forts in the lower Matitanana River valley

Fig. 20. Site 214, Ambinanimananano Atsimo (Labordes 568.2-452.2; 22.03593 S, 48.06707 E)



30 This site of Antanimbaribe (Site 62) near the former mouth of the Manakara River was a large craft production site, occupied during the Marovahiny, Ambohabe, and Sangilavitra phases, with a great amount of iron slag present on the surface. The various types of iron slag recovered seem to indicate that both iron smelting and smithing were performed over many years at this site (Radimilahy 1985, Gabler 2005). Over two field seasons we placed three one-meter square sondages into this site and recovered a large number of artifacts. For example, the seven excavated levels of Sondage 2, only a meter squared, returned 10 pottery sherds, 33 fragments of chlorite-schist vessels, 61 pieces of baked clay, and approximately 1820 pieces of iron slag of various sorts weighing almost two kilograms (Griffin 2009: 361). The chlorite-schist object illustrated in figure 25 was found at this site in Sondage 1, 55 centimeters below ground surface, in the same level as a large piece of clay tuyere. We interpreted this object as a mould meant to receive molten metal, perhaps as a ring mould (based on an observation of similarly shaped metal objects used in south India to create decorative metal bands that were then bent to form rings). This object appears to have been accidentally broken in half while the depression that would have received the molten metal was being carved out. No comparable artifact was recovered from any other site during the *Matitanana Archaeological Project* and there is still some doubt as to its function. There is other evidence for the local working of chlorite-schist at this site of Antanimbaribe in the relatively small fragments of chlorite-schist found in the three excavations that appear to be production debris. Given the excavated evidence at this site for iron smelting and smithing, chlorite-schist working, and the production of charcoal, it is clear that Antanimbaribe was an important center of craft production over an extended period of time, but no quarries were found in the vicinity of this site during our surveys.

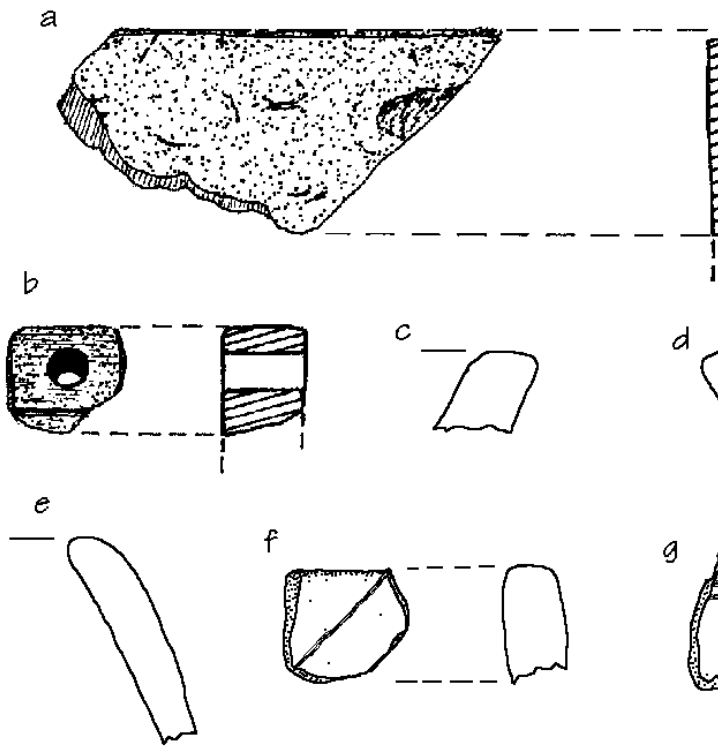
Fig. 21. Site 214A artifacts

A. DECORATED BODY SHERD, BROWN WARE, 6.7g, SAND INCLUSIONS (SIZE 2, 5 %) WITH INTERSECTING INCISED LINES.
B. DECORATED RIM SHERD, COARSE BROWN WARE, 24.6g, D =17 (5 % OF RIM), SAND AND QUARTZ INCLUSIONS (3,10 %), WITH TRIANGULAR AND RECTANGULAR PUNCTATES AND ATTACHED HANDLE, PROBABLY FOR ROPE TO PASS THROUGH TO SUSPEND OR SEAL THE VESSEL.
C. WELL-FORMED, CHLORITE-SCHIST DISK WEIGHT, 17.2 g, D =4.3CM, T =1.2CM, HOLE D =1.04.
D. CHLORITE-SCHIST RIM FRAGMENT, D =28 (5 % OF RIM), WITH INCISED GROOVES ON EXTERIOR (3 LINES MAKING 2 BEVELS) AND REPAIR HOLES (HOLE D =.47CM).

Fig. 22. Site 214D artifacts

a. Decorated rim sherd of hole mouth jar, grey type iE, 8.6g, d =19 (4 % of rim), t = 1.09cm, sand and shell inclusions (3,5 %), with incised lines and precise round impressions from a hollow tool on exterior surface (see Griffin 2009, chapter 5, for details on the pottery typologies used in this project).
b. Decorated body sherd, red type ii, 7.5 g, t =.64, with triangle punctates banded by incised lines.
c. 2 decorated rim sherds that refit, grey type iE, 40.8 g, d = 15 (11 % of rim), t =.60, with deep intersecting grooves that displace clay.
d. Chlorite-schist weight, 10.2 grams, d =2.29, t = .91, hole d =.51, whose center hole is not complete – it was started on each side, but didn't connect.
e. Chlorite-schist base or lid fragment, 26.0g, t =1.43.
f. Decorated rim sherd, brown ware, 22.5g, d = 36 (4 % of rim), t =.73, lip t =.92, sand inclusions (2,5 %), with vertical grooves and wiped exterior surface.
g. Chlorite-schist foot fragment, 86.2 g, interior t =1.06

Fig. 23. Site 214, Sondage 1, Levels 1 to 3 artifacts

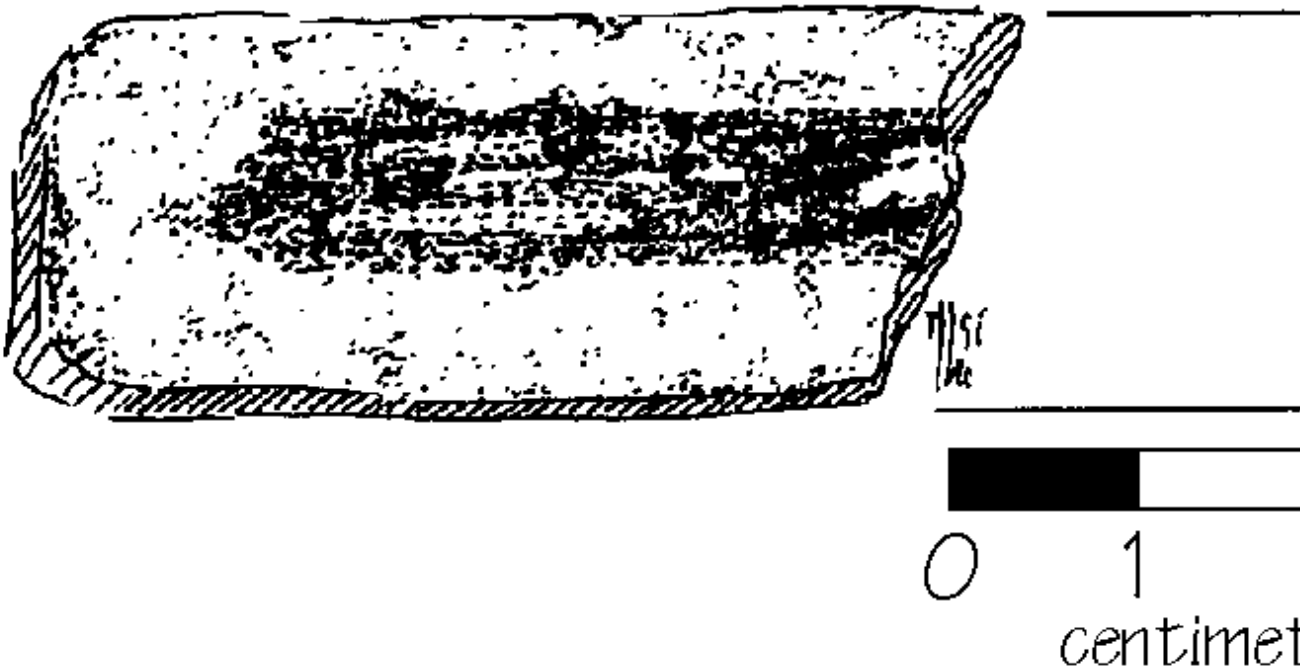


A. S1L1, chlorite-schist possible rim fragment, 23.4 grams, rough section on top as if making grooves and grinding down a rim's lip. If it is a rim being carved, it's D = 52, (3 % of rim).
B. S1L2, chlorite-schist fragment with repair hole, T =.45
C. S1L2, chlorite-schist rim fragment, 3.4g, D =20 (2 % of rim), T =1.06
D. S1L2, plain rim sherd, 3.0g, diameter and orientation uncertain, T =.75, lip T =.68, sand and possibly chlorite-schist inclusions (2,5 %), has a soapy feel.
E. S1L2, plain rim sherd, 10.0g, D =29 (5 % of rim), T =.51, lip T =.64, sand (3,10 %).
F. S1L3, decorated rim sherd, 2.8g, diameter and orientation uncertain, T =.82, lip T =.78, sand (2,5 %), with incised groove on exterior.
g. S1L3, decorated body sherd, soft reddish paste, 2.0g, T =.92, sand and quartz inclusions (2,5 %), with incised double groove.

Fig. 24. Ampandriamboroña, Site 19, artifact (Labordes 560.6-433.8; 22.20317 S 47.9955 E)

CHLORITE-SCHIST WEIGHT, 192 GRAMS, NO MAGNETISM, HOLE DIAMETER .48 TO .65 CM, T = 2.93.

**Fig. 25. Antanimbaribe, Site 62
(Labordes 560.1-432.1; 22.2165 S 47.9905 E), possible ring mould from Sondage 1, Level 5**



CHLORITE-SCHIST MOULD, UNFINISHED AND BROKEN, NON MAGNETIC, 23.1 GRAMS, 5.06 CM X 1.15 CM X .92 CM.

Laboratory Work on Chlorite-Schist

31 We had hoped our fieldwork centered on the Matitanana River would reveal local sources for chlorite-schist, but when that failed we decided to relocate the quarry reported by Pannetier to obtain stone samples (as discussed above). But once the samples were obtained, a method was needed to determine whether or not our artifacts in the main project area originated from these nearest known quarries northwest of Mananjary. Luckily, I was able to participate in a course on Instrumental Neutron Activation Analysis (INAA) at the University of Michigan, graciously taught by Leah Minc (before the Ford Nuclear Reactor was decommissioned in 2003). For this class I prepared and irradiated 48 samples from Madagascar to learn precisely their compositional natures, with the idea that unique geochemical signatures of trace elements could possibly identify different sources for pottery and chlorite-schist. This work was a complex undertaking requiring a familiarity with archaeometry, physics, chemistry and geology, and given my lack of expertise I view my results as provisional. However, I do hope these preliminary results will encourage future work on sourcing chlorite-schist in Madagascar (though probably through a different trace element analysis given the recent closure of many research reactors due to their high costs and security concerns).

32 Twenty-four of my samples were pottery and twenty-four were chlorite-schist samples (twelve from artifacts and twelve from the quarries). The use of NAA to successfully source pottery samples from archaeological sites has been much discussed (see Neff 1992,

and Sinopoli *et.al.* 2006 for a study including a sample taken from the dragon jar found at Kingany (illustrated in Vérin 1986), but also see Sharer *et. al.* 2006 for criticisms). One of my main impressions from the pottery side of this analysis was that a distinctive type of footed bowl, found most commonly on historically important sites and hillforts, probably came from a single clay source and was traded throughout the region. The more common brown and graphite pottery wares, on the other hand, seem to have been produced from multiple clay sources, and thus probably resulted from widespread rather than localized production. This interpretation corresponds with our notion that the footed bowls were a prestige marker that were made in a single location and were more controlled in their distribution, though these conclusions need to be better confirmed (see Griffin 2009: 232 for more details).

33 However, compared to sourcing pottery the sourcing of chlorite-schist through neutron activation analysis has been even more problematic. The ability of NAA to source soft-stone vessels has not been adequately demonstrated, and one of the goals of this side project to my dissertation research was to explore its usefulness with our collection of quarry samples and early artifacts from southeastern Madagascar. Early work on the NAA of soapstone at the University of Virginia (discussed below) claimed it was possible to discriminate between regional sources by comparing the relative concentrations of the rare earth elements. However, this work was followed by a project in the United Kingdom that concluded the opposite. In 1999, the Missouri University Research Reactor (MURR) reanalyzed the Virginia samples in an attempt to resolve the dispute, and determined that the methods could work, but only by focusing on the transition metals rather than the rare earth elements. My project attempted to replicate MURR's findings with soapstone from a different region. It was hoped that this research could be both methodologically significant, in helping to verify the usefulness of this technique for the study of early soapstone vessels, and substantively significant, in helping to trace out the regional trade relations in Madagascar and potentially someday in the wider Indian Ocean.

34 Throughout this paper I have used the term "chlorite-schist," after Vérin 1986, as a translation for the term *chloritoschiste* in the French and Malagasy tradition. In English a more common term for such soft rock is either soapstone or steatite, though some archaeologists have occasionally used other phrasings, such as "soft stone from chlorite sources" (Kohl, Harbottle *et al.* 1979). More precisely, steatite is a metamorphic rock composed mainly of talc with a basic formula of $(Mg, Fe^{+2})_3Si_4O_{10}(OH)_2$ and with minor amounts of other minerals such as chlorite, amphibole or carbonate. One definition of soapstone is amphibole-chlorite-carbonate-talc rocks found with steatite. These are said to be most commonly formed from serpentine rocks in areas of "high tectonic activity such as geosynclinals mountain chains and continental margins" (Allen & Pennell 1978) such as Madagascar. However, as noted above, the term soapstone is generalized in its common usage to include most talcose materials which people can carve into vessels. The term *chloritoschiste* in Madagascar (and hence my term chlorite-schist) is also used in this looser sense to refer to soft stone material from which artifacts can be carved. In fact, the Malagasy material may be harder than the types of soapstone found elsewhere, though this did not pose a problem for the earliest Malagasy who produced their vessels using a lathe technique perhaps related to woodcarving (Pannetier 1974, 1988). At this point, even though my artifact and quarry samples feel soapy, I don't yet know what they actually are, and if they contain enough chlorite to be called "chlorite-schist," a term that

I will continue to utilize in the meantime. To move beyond the semantics, I would like to turn to a discussion of the previous attempts to source this material with NAA.

35 Allen, Luckenbach *et al.* (1975) analyzed 108 soapstone samples drawn from 28 different archaeological sites in Virginia and from 29 different quarries in four southeastern states. Allen and Pennell (1978) then analyzed over 700 samples from the eastern United States, Labrador, and Crete. These articles (along with Rogers, Allen *et al.* 1983) claimed that Instrumental NAA can successfully source soapstone to its quarry on a regional level, in one case even claiming that they could tell when sherds were from the same vessel. The most important elements for sourcing this material in their studies were the rare earth elements (REE). They routinely analyzed 10 of the REE but claimed that it was sufficient to obtain La, Sm, Eu, Gd, and Yb or Lu. Since Allen's teams found the method successful and later groups found it not to be successful, the differences may lay in the actual techniques applied. These studies irradiated between .25 and .6 grams of sample matter for 1 hour at $5x10^{13}$ neutrons, using two standards (basalt BCR-1 and one of their own creation), and then counted the decays between four and ten days and then again between 30 and 40 days.

36 A second group of studies (Buttler 1984; Moffat and Buttler 1986) by a geologist at the Universities Research Reactor, Risley, U.K, claimed that INAA cannot be used to source steatite (or "soapstone"). Buttler further claimed that there is no theoretical geological reason for why it should work (considering the partitioning of REE for this material). He questioned the sensitivity and quality of Allen's work, though he also suggested that perhaps Allen's group may have used longer counting times (in fact, Glasscock and Neff, discussed below, confirmed this difference, reporting that Allen observed decays over a 24 hour period, much longer than Buttler). Buttler's dissertation looked at steatite quarries near the Jarlshof site in Shetland UK. He ran 12 samples with INAA and found that few REE are actually detectable by this method. He then used radiochemical neutron activation analysis (RNAA) and had somewhat better success. Still, the overall scarcity of REE in steatite, and in the serpentinized ultramafic rocks from which it's derived, means that this method shouldn't be expected to work. As for methods, Buttler irradiated 500 mg of rock powder, for 9 hours at 3×10^{12} neutrons, which he then counted immediately for 3000s L, then the following day for 300s, and then after 10-12 days for 3000s L. Each sample was then irradiated a second time for 30 seconds and counted for 200s L after 90 seconds. The standards used included Johnson Mattey 'Specpure' rare earth oxides in dilute nitric acid including Cerium oxide, CRE1 and CRE2.

37 Based on his research, Buttler concluded that rare earth elements are not suitable for "fingerprinting" Shetland steatites, and argued that if the method is to work, one should homogenize a large sample of at least 100 grams to ensure an adequate representation of all minerals in the rock (this would be problematic for me in that most of the vessel fragments I would like to source are less than 10 grams in total weight, and to be prepared for analysis the outer surfaces must be removed with a drill press and the remaining material powdered in a mortar). There are of course other methods to determine the elemental signatures for chlorite-schist, as in Kohl and Harbottle's use of X-ray diffraction to assign 375 samples to four likely sources (two Arabian, one Sumerian, and Tepe Yahya in Iran) (Kohl Harbottle *et al.* 1979). However, many of the same considerations would apply. The problem in Buttler's eyes is that the variation from his largest quarry (sampled six times) was equal to the total variation within the Shetlands (based on his other six samples from four other quarries). The differences between these

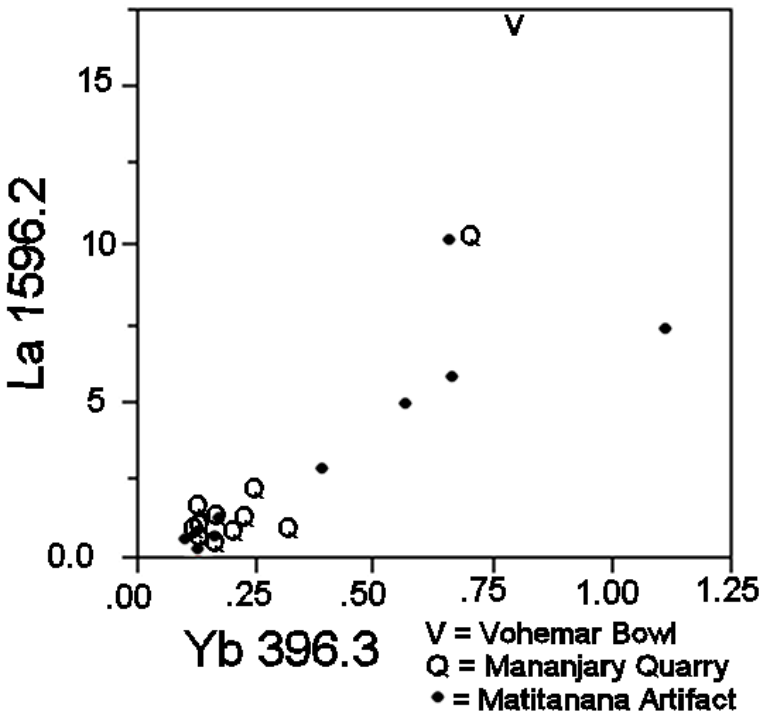
two assessments of soapstone NAA may be due to their different techniques as suggested above (*e.g.*, counting decays for different lengths of time after different amounts of cooling), but may also simply be a factor of sample size. Buttler analyzed very few samples and found great variation among them. Allen's group analyzed enough samples that they reported their results as percentages, such that "80 % of samples" from a given quarry might actually fit his "pattern" for that source.

38 Truncer, Glasscock, and Neff at the University of Missouri Research Reactor (MURR) took up this debate on the use of NAA and the sourcing of soapstone, agreeing with Buttler that the important question is whether the intra-source variation is too great in comparison to the inter-source variation (Truncer, Glascock *et al.* 1998). To answer this question the MURR group re-studied five of Allen's original soapstone quarries, along with three additional quarries from the Middle Atlantic region and a number of vessel fragments dating between 1800 and 800 B.C. They analyzed between 22 and 30 samples from each of the eight quarries. Their methods served as the model for the methods I used at the Phoenix Memorial Lab at Michigan (*e.g.* irradiating 150 mg samples with standards of coal fly ash (SRM-1633a), basalt (SRM-688), and obsidian (SRM-278), with similar counting times, and the standard protocols used at Michigan (see Minc 1994, 2006; and Fowles, Minc *et al.* 2007 for methodological details, and see Law 2011 for a more thorough and comprehensive sourcing of stone artifacts). Based on their research, the MURR group selected 17 elements for analysis, and found that while principle components were not good discriminators of source, bivariate plots of canonical discriminant functions did indeed show quarry groupings. Their conclusions were in agreement with Buttler that the REE are not useful for sourcing steatite, mainly because they are so rare that you would have to homogenize and sample such a large quantity of material that it wouldn't be practical for artifact analysis. On the other hand, they did find that the transition metals could be used to successfully source steatite, though some quarries worked better than others. Also the quarries only produced a generalizable signature that could account for many of the samples, but not all. This makes sense in light of the previous research: sometimes this soft talc rock has a diagnostic signature that can be identified through neutron activation analysis, and in other cases the variation within a single quarry is too great. With this research in mind (and with the help of Leah Minc), I began my study of the chlorite-schist of Madagascar.

39 As I was initially given 48 samples to work with, I reserved 24 for an analysis of the pottery as discussed above. For the chlorite-schist analysis I chose to process 12 samples from the chlorite-schist quarries recorded northwest of Mananjary (sites 237 to 240) along with 1 sample from the finished stone vessel fragment found at quarry site 239. Added to this set were 10 chlorite-schist vessel fragments from the Matitanana region (one of which, MAD041, was a fish net weight from Antanimbaribe, Site 62, see fig. 25). I also included a fragment taken from a bowl in the Museum of Art and Archaeology's collection, a bowl labeled "Voh-4-23" that originated at the site of Vohémar on Madagascar's far northeast coast. The resulting counts after irradiation produced significant numbers of elements with less than detectable limits, as might have been expected from my relatively small artifacts given the discussion above. However, I was able to identify four elements for analysis that might be discriminatory after the short counts: La, Sm, Na, and Yb (along with As and Lu for presence/absence). This situation is not ideal, but at least it includes a light, medium and heavy rare earth element for analysis. Of the 24 chlorite-schist samples, it was determined on the first analytical pass

that MAD033 (a quarry sample) and MAD043 (an artifact) were both outliers or contaminated, being much higher in the REEs than anything else, and were excluded. The Vohémar sample MAD038 was retained, however, even though it was an outlier on sodium. The sample numbers (MAD001 to MAD048) were designed so that I would not know the provenience of individual samples during the analysis. My conclusions — based on only the simplest of statistics at this point (with thanks to Whallon 1987), using multiple scatter plots to identify consistent and robust patterning — can be seen in the bivariate plot of Lanthanum and Ytterbium in figure 26. (The goal of my statistically simple approach was to visually identify robust patterning across multiple cross plots. The scatter plots of Sm by Yb, and others, reveal similar groupings to those discussed below, but obviously more work can be done with this data).

Fig. 26. Ytterbium (Yb) and Lanthanum (La) in chlorite-schist from Madagascar.



40 Based on the bivariate plots, it seems clear that the bowl from Vohémar (labeled V in fig. 26) was carved from a different stone than the chlorite-schist quarries found near Mananjary and also different from the vessel fragments found near the Matitanana. This conforms with a petrographic analysis carried out in the 1950s on the "stone elephant" in Ambohitsara (M.A.P. Site 213), which concluded that this statue was of a different type of stone than that found in the region of Vohémar on the northeast coast (Vérin 1975: 910, as discussed above). Thus, a regional identification of chlorite-schist objects in Madagascar should be possible, at least in terms of the northeast coast versus the rest of the east and southeast coast.

My second rough conclusion from the laboratory work is that the artifact samples from the Matitanana show greater variability among themselves than do the quarry samples, indicating multiple chlorite-schist sources for the artifacts. In starting this analysis, I actually did not expect much overlap between the artifact and quarry samples (as it

seemed unlikely that we would just happen upon the actual source for our stone bowls 156 kilometers north of the Matitanana). However, as seen in repeated scatter plots, four of the artifacts cluster tightly with nine of the quarry samples, creating a robust group. At this point I would be comfortable saying these four stone vessels (and possibly a fifth) found in the Matitanana region originated far to the north in the quarries we located for this project near Mananjary, or from similar outcroppings in the same general area. The other four (or five) artifacts recovered near the Matitanana appear to come from quarries not yet known, which are different from both our sampled quarries and those of the northeast coast near Vohémar.

41 The sampled quarries did produce a consistent signature of trace elements, with the exception of quarry three (M.A.P. Site 239). This was the largest quarry recorded with multiple rock outcroppings, and the three samples submitted for analysis showed the greatest variability. One of these samples was rejected as contaminated or an extreme outlier, and the other two samples can be seen in figure 26 to be the most variable (with the highest amount of Lanthanum). As can also be seen, at least one of the Matitanana artifacts did closely correspond to one of signatures from this highly variable quarry, at least on some of the scatter plots. The stone from this quarry was noted upon collection as being browner than the other three quarries, which were more grey or reddish grey. Thin-sectioning may reveal this quarry to be a different sort of rock than the others, and these results also point to the possibility that macro observations such as stone color may be most useful in combination with elemental composition in determining sources. In this regard I should note that the Vohémar sample was of the same grey color as our other three quarries (though they are clearly different in terms of trace elements), while the chlorite-schist recovered near the stone elephant in Ambohitsara was often more yellow in color.

In the end, this exploratory project in sourcing chlorite-schist in Madagascar was not conclusive, but I do think it points towards some interesting possibilities. There are many ways to improve this initial work (analyzing more and larger samples, from multiple regions, looking more closely at the transition metals, and using more appropriate numerical measurements of clustering tendencies and principle components). However, I do think the general clusters that I've identified should be able to withstand more complex manipulations of the data, and I credit Minc's class at the University of Michigan for helping to get things this far. Hopefully, future chlorite-schist research in Madagascar can be done in conjunction with such archaeometry specialists to provide a more robust analysis. As for the method itself, trace element analysis through NAA does seem to be able to successfully source earthenware pottery in the Matitanana region, even cross-cutting my ware typology at times, as well as regionally characterize the chlorite-schist stone sources.

42 The *Matitanana Archaeological Project* (Griffin 2009) primarily consisted of surface surveys and small excavations with an eye towards constructing the culture history of the region. In the course of this work much was also discovered about the production and consumption of chlorite-schist vessels, as detailed in this paper. Creating the ceramic chronology displayed in table 1 also revealed some interesting interactions between pottery and chlorite-schist artifacts found along the Matitanana. The earliest sites tended to have both chlorite-schist vessels and heavy earthenware vessels that used large pieces of broken chlorite-schist as grog. In the next phases, some artifacts were recovered that show the chlorite-schist having been ground down to a powder to be included as a temper

in the clay instead of using visible chunks as grog. And then as a final transformation in the most recent phases, once chlorite-schist was not longer imported to the area, graphite seems to have been added to the clay as a type of import substitution replacing the earlier stone inclusions. All of these manipulations gave the clay pottery the reflective appearance and soapy texture of the original chlorite-schist vessels. The first pottery inclusions (chlorite-schist grog) seem to indicate a cultural need to have at least some chlorite-schist included in all cookware, while the later developments (to chlorite-schist powder and then to graphite temper) seems to reflect a desire for both cookware and serving vessels to mimic the older chlorite-schist vessels. In terms of import substitution, we also found some rim sherds that appear to imitate the shape and decoration of the stone vessels, even from the earliest phases.

43 While not quarried in the Matitanana region itself (as far as we can tell at present), carved chlorite-schist vessels were clearly an important component of life along Madagascar's southeastern coast for many centuries. Its value seems to have led to the creation of local imitations, even after it was no longer available for importation. As demonstrated through the NAA analysis, some of these chlorite-schist vessels appear to have originated in the four quarries near Mananjary documented in this paper. These quarries, visited earlier by Pannetier (1974), can provide a useful comparative case to the better known industrial sites near Vohémar on the northeast coast. The distribution across Madagascar of archaeological sites with chlorite-schist remains, including those newly documented for the *Matitanana Archaeological Project*, can help us to better understand the early trade networks and past regional connections, especially if we can link the artifacts to quarry sources. Hopefully the study of this important material in the field and in the lab will attract increasing attention in the future.

Table 3. Chlorite-schist NAA results, week 1 counts (week 5 counts available from author)

Samples	Location	Type	As 559.1	La 1596.2	Lu 208.4	Sm 103.2
MAD025	quarry	Q1	3.575	0.372173	0	0.109536
MAD026	quarry	Q1	2.209	1.087	0	0.292357
MAD027	quarry	Q1	2.392688	0.4978598	0	0.033
MAD028	quarry	Q1	3.107488	0.4612712	0	0.132101
MAD029	quarry	Q4	0	1.39997	0	0.1945498
MAD030	quarry	Q2	2.011796	0.6388981	0	0.0784954
MAD031	quarry	Q2	1.214297	0.2237658	0	0.2311827
MAD032	quarry	Q2	2.475534	0.8036258	0	0.3183905
MAD033	quarry	Q3	0	87.82999	0.3085896	12.63158
MAD034	quarry	Q3	0	10.28589	0.1111427	2.165291
MAD035	quarry	Q3	0	2.293006	0	0.5134462

MAD036	quarry	Q4	0	0.3244706	0	0.070572
MAD037	quarry	artifact	0	0.7551702	0	0.3304127
MAD038	Vohemar	artifact	0	16.86266	0.1224413	3.357515
MAD039	Mat	artifact	0	7.438999	0.1723649	2.452312
MAD040	Mat	artifact	0	0.6886176	0	0.270294
MAD041	Mat	net.wt	0	0.6046584	0	0.0967103
MAD042	Mat	artifact	0	10.20889	0.0952518	1.854079
MAD043	Mat	artifact	0	14.37148	0.3270923	4.484989
MAD044	Mat	artifact	0	2.896285	0.076797	0.5014527
MAD045	Mat	artifact	0	4.991822	0.0881468	0.8079461
MAD046	Mat	artifact	0	5.757995	0.1417995	1.96129
MAD047	Mat	artifact	0	1.273568	0.0227534	0.1765831
MAD048	Mat	artifact	0	0.1498461	0.0189694	0.0615553

Na 1368.6	U 277.6	Yb 396.3	
178.854	0.338518	0.129312	
206.575	0.690622	0.201986	
173.4324	2.200543	0.1190904	
200.3756	-0.5679422	0.1427522	
139.8567	-0.4722447	0.1134989	
176.1595	-0.5735747	0.1308052	
181.558	-0.4810415	0.1247879	
197.7757	-0.7001252	0.3112757	
227.9324	-0.6604626	2.322632	
622.5906	-0.538588	0.6961198	
193.9324	0.6949878	0.2435998	
157.3884	0.6857202	0.1493023	

258.0583	-0.7408247	0.1566168	
767.5961	-0.7313387	0.8053472	
338.6176	-0.9261979	1.112657	
200.1321	-0.7619004	0.1735023	
279.067	-0.5665169	0.1104938	
312.5895	-0.9219181	0.657741	
373.666	-0.8964923	2.251636	
233.2669	-1.034018	0.4002465	
116.0871	-1.050428	0.5800547	
272.1436	-1.074484	0.6685436	
439.2284	-0.927225	0.1763565	
420.4609	-0.7998005	0.1378802	
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NOTES

1. Completed, of course, with the help of many others. I particularly want to thank Jean-Aimé Rakotoarisoa, Henry Wright, and Ramilisonina for enabling the fieldwork, Rambeloarison and Jeannot for the better illustrated artifacts in this paper, and Zoe Crossland, Victor Razanotovo and others for serving in the field crew.

2. The unpublished manuscript I obtained at the Museum of Art and Archaeology was a version of Pannetier's thesis in the process of being prepared for publication by the museum, with a date

of 1988 on the title page. It was most likely written in the mid 1970s, and had not yet been published, but hopefully will be released at some point.

3. There was also one other scholar who had undertaken archaeological research in the area to my knowledge: Elie Rajaonarison first came to the Matitanana under the auspices of the Urban Origins Project, for which he produced a few reports based on his research (Rajaonarison 1989, 1990). Rajaonarison became more interested in the *Sorabe* texts, and went on to produce some of the most insightful analysis of this literature (*e.g.*, Rajaonarison 1994).

RÉSUMÉS

Ce document rend compte des différents aspects du projet archéologique *Matitanana* traitant, entre autres, de l'industrie en chloritoschiste trouvée dans le sud-est de Madagascar. Les sites de carrière découverts près de la ville moderne de Mananjary sont décrits, ainsi que d'autres sites non exploités apportant la preuve du travail du chloritoschiste près de Manakara et dans la vallée du fleuve Matitanana, plus au sud. Un essai préliminaire visant à relier les sites de production et d'utilisation, grâce à l'emploi de l'analyse par activation neutronique, suggère que certains des artefacts « Matitanana » proviennent des carrières de Mananjary, d'autres de carrières encore inconnues. On note que ces deux groupes diffèrent des pièces en chloritoschiste que l'on retrouve fréquemment près de Vohémar. Il est à espérer que les recherches futures seront en mesure d'apporter des solutions aux questions que posent ces différences.

This paper reports on different aspects of the *Matitanana* archaeological project relating to the chlorite-schist stone vessels found in southeastern Madagascar. Quarry sites discovered near the modern city of Mananjary are described, as are other non-quarry sites with evidence for the working of chlorite-schist material near Manakara and the Matitanana River valley to the south. A preliminary attempt to link the production and consumption sites, through the use of neutron activation analysis, suggests that some of the Matitanana artifacts did come from the Mananjary quarries, that other artifacts came from other as yet unknown quarries, and that both of these groups differ in their trace elements from the stone commonly found near Vohémar. It is hoped that future research will be able to further clarify many of these issues.

INDEX

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